

Application No. 10/043,534

Reply to Office Action

*REMARKS/ARGUMENTS**The Pending Claims*

Claims 1-27 are currently pending. The pending claims are directed to a system for polishing a substrate comprising a liquid carrier, ammonium oxalate, a hydroxy coupling agent, and a polishing pad and/or an abrasive, wherein the system does not comprise an oxidizing agent. The pending claims are also directed to a method of polishing a substrate using the aforementioned polishing system.

Summary of the Office Action

Claims 1-8, 10-13, and 15-27 stand rejected under 35 U.S.C. § 103(a) as allegedly unpatentable over Motonari et al. (i.e., U.S. Patent 6,447,695) (hereinafter "the Motonari '695 patent") in view of Sinha et al. (i.e., U.S. Patent 6,551,935) (hereinafter "the Sinha '935 patent"). Claims 9 and 14 stand rejected as allegedly unpatentable over the Motonari '695 patent in view of the Sinha '935 patent and further in view of Allman et al. (i.e., U.S. Patent 6,541,383) (hereinafter "the Allman '383 patent"). In addition, claims 19 and 25 stand rejected as allegedly unpatentable over the Motonari '695 patent in view of the Sinha '935 patent and further in view of Ni (i.e., U.S. Patent 6,503,766) (hereinafter "the Ni '766 patent").

Discussion of the Obviousness Rejections

The Office Action asserts that the subject matter of pending claims 1-8, 10-13, and 15-27 is obvious in view of the combined disclosures of the Motonari '695 patent and the Sinha '935 patent. In particular, the Office Action relies on the Motonari '695 patent for its disclosure of an aqueous dispersion comprising water, an abrasive, and a silane coupling agent (e.g., a hydroxyl coupling agent), wherein the aqueous dispersion normally contains no oxidizing agent. The Office Action recognizes that the Motonari '695 patent does not specifically disclose using ammonium oxalate in the aqueous dispersion. The Office Action relies on the Sinha '935 patent for its disclosure of a method for using a planarizing solution comprising ammonium oxalate employed in a polishing system further including a polishing pad and abrasives. Since the Sinha '935 patent is directed to a polishing system for polishing metal using an aqueous dispersion, the Office Action alleges that one of ordinary skill in the

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art would have found it obvious to modify Motonari's aqueous dispersion to incorporate ammonium oxalate because the Sinha '935 patent discloses that one or more buffers such as ammonium oxalate may be used to adjust the pH of the slurry to a desired level.

Contrary to the Office Action's assertions, one of ordinary skill in the art, at the time of invention, would not have been motivated to combine the disclosures of the Motonari '695 and Sinha '935 patents in such a way as to arrive at the invention defined by the pending claims. The Motonari '695 patent discloses an aqueous dispersion comprising a polishing agent, water, and a polishing rate adjustor. The polishing agent comprises inorganic particles or organic/inorganic composite particles wherein the composite particles may comprise a polycondensate bonded to a polymer particle via a silane coupling agent. As recognized by the Office Action, the Motonari '695 patent further teaches that the aqueous dispersion disclosed therein normally does not comprise an oxidizing agent. Although the Motonari '695 patent teaches that the aqueous dispersion disclosed therein can be used for polishing of various types of working films including pure copper films, pure aluminum films, and pure tungsten films, (see, e.g., the Motonari '695 patent at col. 7, lines 11-21), the Motonari '695 patent teaches that the aqueous dispersion is particularly suited to be able to polish *barrier metal layers made of tantalum and the like* at a sufficient rate without excessively polishing wiring materials made of copper or the like, or excessively polishing insulating films (see, e.g., the Motonari '695 patent at col. 1, lines 42-52).

By way of contrast, the Sinha '935 patent is generally directed to slurries and methods that are used to polish or planarize *electrically conductive structures of semiconductor devices that include copper and an adjacent tungsten-containing barrier layer* (see, e.g., the Sinha '935 patent at col. 1, lines 9-17). The slurry disclosed in the Sinha '935 patent generally comprises an abrasive and an oxidizer component, which oxidizes both copper and a tungsten-containing material of a barrier layer (see, e.g., the Sinha '935 patent at col. 5, lines 6-19). The Sinha '935 patent specifically distinguishes slurries that are useful for polishing substrates comprising copper or copper and tungsten from slurries useful for polishing substrates comprising tantalum. In particular, the Sinha '935 patent teaches that the oxidizers of slurries that remove copper do not adequately effect the removal of tantalum and that slurries useful for removing tantalum are not effective for removing copper (see, e.g., the Sinha '935 patent at col. 2, lines 4-8). The Sinha '935 patent further teaches that the slurries

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disclosed therein can comprise a pH control agent (e.g., a buffering agent). Suitable pH control agents disclosed in the Sinha '935 patent include potassium hydrogen phthalate, ammonium phosphate, ammonium acetate, ammonium dihydrogen phosphate, dibasic ammonium citrate, ammonium hydrogen phosphate, tribasic ammonium citrate, ammonium oxalate, ammonium carbamate, acetic acid, phosphoric acid, and sulfuric acid.

Thus, rather than motivating the ordinarily skilled artisan to modify the aqueous dispersion disclosed in the Motonari '695 patent in such a way as to arrive at the invention defined by the pending claims, the Sinha '935 patent specifically teaches that slurries containing oxidizing agents are not suitable for the polishing of a tantalum-containing substrate, which is the subject of interest of the Motonari '695 patent. Therefore, contrary to the Office Action's assertions, the ordinarily skilled artisan, having considered the disclosure of the Motonari '695 patent and in particular the utility of the aqueous dispersion thereof in the polishing of tantalum, would not look to the disclosure of the Sinha '935 patent for modifications to the dispersion disclosed therein. Indeed, nothing within the disclosure of the Sinha '935 patent teaches or suggests that a buffering agent would be suitable for use in an aqueous dispersion of the type disclosed in the Motonari '695 patent. Further, nothing within the disclosure of the Sinha '935 patent teaches or suggests the particular suitability of ammonium oxalate as compared to any of the other buffering agents recited therein for the polishing of any metal, let alone a tantalum-containing substrate which is the subject of interest of the Motonari '695 patent.

In order to establish a case of *prima facie* obviousness, the suggestion or motivation to make the claimed combination must be found in the prior art, rather than in applicants' disclosure. See, e.g., *In re Vaack*, 947 F.2d 488, 493, 20 U.S.P.Q.2d 1438, 1442 (Fed. Cir. 1991). The Office Action, however, fails to properly identify a suggestion or motivation that would have caused one of ordinary skill in the art, at the time of invention, to combine the disclosures of the cited references in such a way as to arrive at the invention defined by the pending claims.

The unexpected improvement in copper polishing performance discovered for oxidizer-free polishing compositions comprising ammonium oxalate and a hydroxyl coupling agent further emphasizes the unobviousness of the invention as recited in the pending claims

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in view of the combined disclosures of the Motonari '695 and Sinha '935 patents. In particular, Applicants unexpectedly found that oxidizer-free polishing compositions comprising fumed silica, gamma-ureidopropyltrimethoxysilane (e.g., a hydroxyl coupling agent), and ammonium oxalate *but not* potassium oxalate, aminotri(methylenephosphonic acid), ammonium sulfate, ammonium acetate, or diammonium EDTA, which are also, *inter alia*, buffering agents, provides for enhanced removal rates for copper. The Example set forth in the instant specification compares copper removal rates observed for several oxidizer-free polishing compositions comprising fumed silica, gamma-ureidopropyltrimethoxysilane, and several additives when used to polish substrates comprising copper, tantalum, and TEOS. In particular, a polishing composition comprising 1 wt.% ammonium oxalate exhibited a copper removal rate of 673 Å/min, whereas a polishing composition comprising 1 wt.% ammonium acetate exhibited a copper removal rate of only 227 Å/min. Thus, the results set forth in the Example demonstrate the unexpected properties of polishing compositions comprising ammonium oxalate as compared to similar polishing compositions comprising ammonium acetate or other buffering agents.

In view of the foregoing, the invention defined by the pending claims cannot properly be considered obvious over the combined disclosures of the Motonari '695 and Sinha '935 patents. The combination of a hydroxyl coupling agent and ammonium oxalate could only be accomplished from the disclosures of the Motonari '695 and Sinha '935 patents through the use of improper hindsight knowledge of the present invention. Moreover, the unexpected results exhibited by the claimed invention are sufficient to rebut any allegation of obviousness based on the combined disclosures of the Motonari '695 and Sinha '935 patents. For the foregoing reasons, the obviousness rejection of claims 1-8, 10-13, and 15-27 should be withdrawn.

The Office Action further asserts that claims 9 and 14 are obvious in view of the Motonari '695 and Sinha '935 patents considered with the Allman '383 patent. In particular, the Office Action relies on the Allman '383 patent for its disclosure of gamma-ureidopropyltrimethoxysilane in an aqueous polishing composition. The Allman '383 patent does not cure the deficiencies of the Motonari '695 patent and the Sinha '935 patent. The Allman '383 patent relates to an apparatus and method for planarizing the surface of a semiconductor wafer. The method disclosed in the Allman '383 patent comprises the

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application by spraying of an adherence promoting ligand (e.g., gamma-ureidopropyltrimethoxysilane) onto a wafer track of a planarization surface (the Allman '383 patent at col. 6, lines 52-54) followed by spraying of abrasion particles onto the wafer track (the Allman '383 patent at col. 7, lines 36-38), such that the abrasive particles are chemically bonded to the planarizing surface. Apart from a pH control solution, the Allman '383 patent is silent as to other chemical components useful in the disclosed method. Nothing within the Allman '383 patent suggests or discloses that an adherence promoting ligand such as a ureidopropyltrimethoxysilane in combination with ammonium oxalate would have utility in a polishing system as defined by the pending claims. Further, the unexpected properties exhibited by polishing compositions comprising gamma-ureidopropyltrimethoxysilane and ammonium oxalate as discussed herein are sufficient to rebut any allegation of obviousness based on the combined disclosures of the Motonari '695, Sinha '935, and Allman '383 patents. Accordingly, the obviousness rejection of claims 9 and 14 should be withdrawn.

Claims 19 and 25 stand rejected as obvious over the disclosures of the Motonari '695 and Sinha '935 patents considered with the Ni '766 patent. The Ni '766 patent relates to a method and system for detecting an exposure of a material on a semiconductor wafer during chemical-mechanical polishing (see, e.g., the Ni '766 patent at the abstract). The Ni '766 patent does not cure the deficiencies of the Motonari '695 patent and the Sinha '935 patent. The Ni '766 patent does not teach or suggest a polishing system comprising a liquid carrier, ammonium oxalate, a hydroxy coupling agent, and a polishing pad and/or an abrasive, wherein the system does not comprise an oxidizing agent. Moreover, although the Ni '766 patent discloses that the removal rate of a substrate being polished can be "optimized" by adjusting polishing parameters such as polishing pressure or down force, belt speed, carrier speed, polishing agent flow, and the like, nothing within the Ni '766 patent teaches or suggests that a polishing system comprising a polishing pad and/or an abrasive, a hydroxyl coupling agent, and ammonium oxalate can exhibit any particular polishing selectivity of copper to tantalum, let alone a polishing selectivity of copper to tantalum that is at least about 1:1. Accordingly, the obviousness rejection of claims 19 and 25 should be withdrawn.

Conclusion


Applicants respectfully submit that the present application is in condition for allowance. If, in the opinion of the Examiner, a telephone conference would expedite the

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prosecution of the subject application, the Examiner is invited to call the undersigned attorney.

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